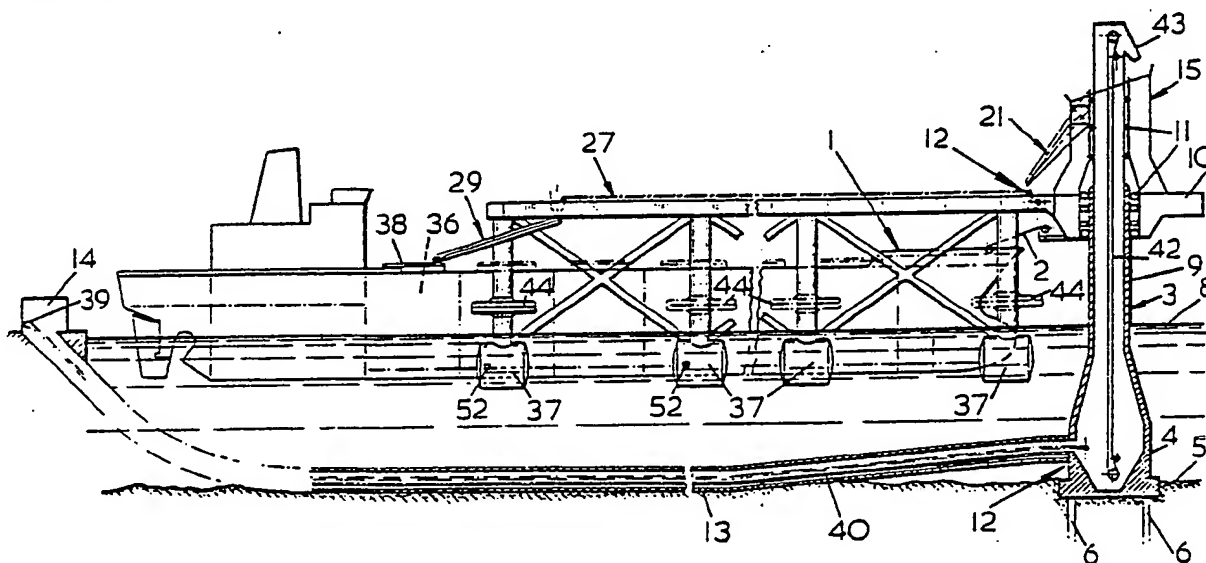




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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**(54) Title:** AZIMUTHAL MOORING MATERIAL HANDLING TERMINAL AND TOWER



**(57) Abstract**

The present invention relates to the loading and unloading of bulk carrier vessels with particulate material and provides an azimuthal mooring tower (3) for use in loading or unloading particulate material onto or from a bulk carrying vessel (1). The tower (3) has a base (4) in a body of water (8) accessible to the vessel (1), and an upper portion (9) supporting a rotatable portion (10) provided with a mooring means (2). The tower (3) has an opening (12) connected to a tunnel (13) provided with conveying means (40) below the hull of the vessel (1). The tower (3) has a material conducting means (42) extending upwardly for conducting material between said tunnel (13) and a distribution means (15) having a portion (21, 27, 29) extending generally radially and movable with the rotatable portion (10) for discharging or receiving material away from said tower (3) during loading or unloading of the vessel (1).

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AZIMUTHAL MOORING MATERIAL HANDLING TERMINAL AND TOWERTECHNICAL FIELD

This invention relates to an azimuthal mooring tower suitable for use in loading and unloading particulate material such as coal onto or from a bulk carrying vessel and the use thereof.

BACKGROUND ART

Due to the increase in cost and other disadvantages of other alternative energy sources, coal is becoming an increasingly important fuel. With the increasing importance of remote coal sources in Australia and elsewhere there is an increasing amount of coal being carried by bulk carrier vessels. Although transport costs are significantly reduced with increased size vessels, the use of such vessels often necessitates expensive dredging and/or wharf construction to accommodate such vessels as well as the considerable berthing costs and times involved with the need for tugs to be in attendance for extensive periods of time. In some cases there may even be a need for loading or unloading coal onto or from the vessel with the aid of smaller inshore vessels which considerably increases the time and labour involved and hence the costs of loading or unloading. Thus in general conventional methods for loading or unloading such vessels are slow and inconvenient as well as being expensive.



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It is an object of the present invention to avoid or minimize one or more of the above difficulties.

#### DISCLOSURE OF INVENTION

The present invention provides an azimuthal

5 mooring type tower for use in loading or unloading particulate material onto or from a bulk carrying vessel, which tower has a base securable to the ground in a body of water accessible to said vessel, and an upper portion supporting a rotatable portion mounted for rotation around

10 said upper portion and provided with a mooring means, said tower having an opening below said upper portion for connection, in use of said tower, to a tunnel provided with material conveying means and extending below the level of the hull of a said vessel moored at said tower,

15 said tower including a material conducting means extending upwardly from a position in proximity to said opening for conducting, in use of the tower, material between said tunnel, and a material distribution means having a portion extending generally radially of said rotatable portion and

20 arranged for rotation therewith and for discharging or receiving material at at least one position spaced from said tower, for loading or unloading, respectively, of a vessel moored to said rotatable portion, in use of said tower.

25 In one aspect the invention provides an azimuthal mooring type tower for use in loading material onto a material carrying vessel, which tower has a base securable to the ground in a body of water accessible to said vessel, and an upper portion supporting a rotatable

30 portion mounted for rotation around said upper portion and provided with a mooring means, said tower having an opening below said upper portion for connection, in use of said tower, to a tunnel provided with material conveying means and extending below the level of the hull of a said

35 vessel moored to said tower, said tower including a

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material elevating means extending upwardly from a position in proximity to said opening for conveying, in use of the tower, material carried through said tunnel, up to said upper portion for discharging material thereat onto a material distribution means having a portion extending generally radially of said rotatable portion and arranged for rotation therewith and for discharging material at at least one position spaced from said tower, for loading of a vessel moored to said rotatable portion, in use of said tower.

In another aspect the invention provides an azimuthal mooring unloading tower suitable for use in unloading coal from a coal carrying vessel, said tower having: a base securable to the ground in a body of water accessible to said vessel; an upper portion provided with receipt means for receiving coal discharged from a vessel in use of the tower and directing the coal downwardly through the tower towards said base; an opening below said upper portion for connection, in use of said tower, to a tunnel provided with coal conveying means and extending below the level of the hull of a said vessel moored at said tower; and a rotatable portion having mooring means for securing of a vessel thereto, said mooring portion being rotatable around a vertical axis of the tower to permit azimuthing of the vessel, due to wind and/or tidal forces, around the tower whilst remaining moored thereto, in use of the tower.

In a further aspect of the present invention an azimuthing mooring type loading or unloading terminal comprises an azimuthing mooring type tower according to the present invention disposed in a position in a body of water accessible to a bulk carrying vessel with the base of said tower secured to the ground in said body of water and with the top of said tower projecting above a high-water level, a tunnel extending between said tower at a level, at least in proximity to said tower, below the

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level of the hull of a said vessel moored to said tower, and a remote supply point, said tunnel including conveyor means for conveying material between said tower and said supply point.

5           This invention also provides a method of loading or unloading particulate material onto or from a vessel comprising the steps of mooring the vessel at the rotatable portion of an azimuthal mooring type tower of an azimuthal mooring type loading terminal according to the  
10 present invention; positioning a discharging or receiving portion of said radially extending portion of the material distribution means above a hold opening of the vessel; using the tunnel material conveying means, tower material conducting means, and coal distribution means to convey  
15 material between said vessel and said remote supply point.

Normally it will of course be necessary to adjust the position of the vessel and a discharge or receiving part of said radially extending portion of the coal distribution means relative to each other, to facilitate loading of different parts of the hold and/or different  
20 holds of the vessel.

Since, with the present invention, it is possible to site the loading or unloading tower at any convenient location in particular in water deep enough to enable safe  
25 and easy access to the largest bulk carriers, the additional costs and labour involved in the use of smaller shore based vessels and or the large expenses of providing piers of adequate length are avoided and berthing costs significantly reduced, the mooring of a vessel using an  
30 azimuthal mooring system being in general particularly simple due to the freedom to approach the mooring point from different directions to suit different wind and tidal conditions etc.

BRIEF DESCRIPTION OF DRAWINGS

Further preferred features and advantages of the invention will appear from the following description given by way of example of various embodiments of the invention  
5 illustrated with reference to the accompanying drawings in which:

Figure 1 is a generally schematic partially sectioned side elevation of an azimuthal mooring and loading terminal of the invention with a vessel moored  
10 thereat;

Figure 2 is a detail partially sectioned view corresponding to Figure 1 showing the tower and part of the distribution means thereof;

Figure 3 is a partial plan view of the terminal  
15 of Figures 1 and 2;

Figure 4 is a schematic transverse sectional view of the radial portion of the terminal and the vessel therein;

Figure 5 is a detail side view of the tower  
20 showing various parts of the distribution means thereof;

Figure 6 is a view corresponding generally to Figure 1 of an alternative embodiment;

Figure 7 is a general partly sectioned view of a third embodiment end on to the mooring means thereof;

25 Figure 8 is a transverse cross-section of the terminal of Figure 7 through an elongate pier member and a vessel moored thereat;

Figure 9 is a partial plan view of the tower and part of the rotatable portion mooring means thereof of  
30 Figs. 7 and 8;

Figure 10 is a detail view corresponding to Fig. 7 of the annular coal conveyor of the embodiment of Figs. 7 to 9;

Figure 11 is a generally schematic part-sectioned  
35 side view of part of a modified terminal similar to that of Figs. 7 to 9 side on to the rotatable portion mooring means;

Figure 12 is a generally schematic view corre-



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sponding to Fig. 1 of a first azimuthal mooring unloading terminal of the invention;

Figure 13 is a detail view corresponding to Figure 12 of a second unloading terminal of the invention;  
5 and

Figure 14 is a schematic transverse sectional view of the radial portion of the terminal of Figure 13 and two vessels thereat.

### MODES FOR CARRYING OUT THE INVENTION

10 Figure 1 shows a coal carrying vessel 1 secured by conventional mooring means 2 to an azimuthing mooring unloading tower 3. The tower 3 comprises a base 4 secured to the sea bed 5 by suitable means e.g. piles 6, an upper  
15 portion 7, extending up above the waterline 8 and an interconnecting portion 9.

The upper portion 7 rotatably mounts a rotatable portion 10 via bearing means 11. The vessel 1 is moored to the rotatable portion 10 so that the vessel 1 can swing around the tower 3 under the influence of e.g.  
20 wind and tide to a greater or lesser extent - subject to the use of internal thruster means of the rotatable portion as will be further described below, to counteract the influence of the wind and/or tide, whilst remaining moored at said tower.

25 At or in proximity to the base 4, the tower 3 is provided with a side opening 12 at which is connected one end of a tunnel 13 which extends along or under the sea bed 5 from the base 4 of the tower 3 to a remote supply point 14 which is conveniently on dry land, for example,  
30 at a convenient stock pile or rail head.

The rotatable portion 10 is provided with a coal distribution means 15 which is in the form of a generally annular chute means 16 which is inclined so as to extend obliquely of the vertical axis of the tower 3 and slope



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downwardly from an upper end 17 to a lower end 18.

At the lower end 18 there is provided a flap valve 20 (see Figure 3) arranged for diverting coal to either one of two outwardly extending discharge chutes 21  
5 for permitting coal to pass to both said chutes 21 simultaneously.

As may be seen in Figure 3, the rotatable portion 10 is generally V-shaped with its approximate geometric centre generally coincident with the central vertical axis 22 of the tower 3 and with its two limb portions 23 extending generally outwardly of the tower 3, the free ends 24 of limb portions 23 being connected to respective ones of two elongate members 25 by respective, coaxial and horizontally extending, pivotal connections 26. The  
15 elongate members 25 extend parallel to and spaced from, each other on either side of the vessel 1 and generally radially of the tower 3.

On the elongate members 25 are provided conveyor means 27 of various lengths with their inboard (relative to the tower 3) ends 28 disposed for receiving coal from the respective discharge chutes 21 and with further, optionally telescopic, discharge chutes 29 at their respective outer ends 30. As seen in Figures 3 and 4, rotatable hopper means 31 are provided at the outboard  
25 ends 30 of the conveyor means 27 with the further discharge chutes 29 connected to the lower ends 32 of the hoppers 31 for rotation together therewith about a generally vertical axis. In addition the connections 33 between the further discharge chutes 29 and the  
30 hoppers 31 are formed so as to permit pivotal movement thereof about a generally horizontal axis with the aid of suitable piston and cylinder means 34 (preferably of hydraulic type) whereby the free ends 35 of said further discharge chutes 29 can be raised or lowered. This free-  
35 dom of movement of the further discharge chutes 29 (which

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correspond to the discharge ends of the distribution means 15) enables their position to be changed relative to vessel 1 thereby enabling different parts of the hold(s) 36 to be efficiently loaded in a simple and efficient manner.

5           As may be seen in Figures 2 and 4 in particular, the elongate members 25 are of a framework type of construction, conveniently of steel, provided with float or buoyancy means in the form of sponsons 37 which support the members 25 in the water in a substantially horizontal  
10 position with the conveyor means 27 at a level above the hatches 38 of the hold(s) 36 of the vessel 1. The rotatable portion 10 is also supported through its connections 26 to the members 25 but is free to rise and fall, together with the elongate members 25, relative to the tower 3, e.g.  
15 due to tidal differences, by virtue of the bearing means 11. At the same time a degree of pitching of the elongate members 25 due to wave action and the like, relative to the rotatable portion 10 can be accommodated by relative pivotal movement through the pivotal connection 26 there-  
20 between.

          If desired the elongate members 25 may be provided with control means 52 for varying the buoyancy of the sponsons 37 to adjust the trim of the elongate members 25 relative to the trim of the vessel 1 and/or  
25 to maintain the members at a constant level relative to the tower 3 under varying tidal conditions etc.

          As may be seen in Figure 3 the outwardly extending chutes 21, and elongate members 25 with their conveyors 27, and further discharge chutes 29, extend generally  
30 radially of the tower 3 and thus, together constitute a radial portion of the coal distribution means 15, further details of whose construction may be seen in Figure 5.

          In use of the terminal coal is fed at the shore based supply point 14 onto one end 39 of a conveyor  
35 means 40, preferably duplicate, which extends through the

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tunnel 13 via the side opening 12 in the tower into the base 4 of the tower 3 to discharge coal into the interior 41 of the base 4, which interior is generally hopper shaped. A coal elevating means, preferably duplicate and conveniently in the form of a bucket elevator 42 extending substantially vertically inside the tower, picks up coal from the interior 41 of the base 4 and carries it up into the upper portion 7 of the tower 3 whence it discharges the coal via an outwardly extending and downwardly inclined outlet 43 onto the annular chute 16. Depending on the relative angular positions of the tower 3 and rotatable portion 10, the coal may be discharged anywhere between the upper and lower ends 17, 18 of the annular chute 16 but will always end up passing through the lower end 18, and flap valve 20 onto the outwardly extending chutes 21 and thence onto the conveyors 27 on the elongate members 25 and finally via the further discharge chutes 29 and hatches 38 into the hold(s) 36 of the vessel 1.

Although with azimuthal mooring systems in general the mooring cable(s) normally remain under tension, the vessel tending to swing about the mooring point, only, it is possible under certain conditions that the vessel may be moved e.g. by tidal forces, towards the tower 3 and the latter is therefore advantageously provided with suitable protection means such as inflatable fenders to avoid any possible collision damage. The elongate members 25 are also desirably provided with, desirably rotatable, annular fender means e.g. as indicated at 44 in Figure 1.

It will be appreciated that with such a loading system, loading can be made very simple and labour requirements reduced to a minimum level. Thus by suitable choice of the location of the tower the latter can be made accessible to the largest vessels which can be simply and quickly moored thereto. Then once a discharge end of the radial portion of the coal distribution means has been positioned over the hold, loading can proceed substantially

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continuously and automatically without the need of any manual labour - it being only necessary to adjust the position(s) of the discharge end(s) and vessel relative to each other to facilitate complete loading of all the  
5 hold space.

It will also be apparent that various modifications can be made without departing from the scope of the invention as defined in the following claims. Thus the tunnel may be disposed under the sea bed or possibly  
10 even supported above the sea bed as long as it is positioned well clear of the hull of any vessel approaching the tower or moored to the tower on any side thereof to permit azimuthing of the vessel through 360° around the tower. Naturally the inshore end may extend well above  
15 the water line depending on the form of the shore and the location of the discharge point. In general any conventional form of tunnel construction which is substantially watertight may be employed, for example, the tunnel may be made of steel or reinforced concrete and/or of  
20 precast concrete sections assembled in situ and preferably is provided with ballast compartments 53 to minimize buoyancy. The tower itself may also be made by any form of construction suitable for use in such a structure - as for example for off-shore oil exploration and production  
25 platforms. Conveniently, though the tower may be made of reinforced concrete and/or steel plate construction.

It will also be appreciated that the present invention is applicable to various particulate materials though it is of greatest significance in connection with  
30 dry coal - whether in the form of rock coal or smaller size coal - and materials of similar size and consistency e.g. minerals such as iron ore or phosphate rock, as these can not be so readily handled in conventional continuous loading and unloading systems available for use with  
35 fluids or grain.

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The terminal is desirably weatherized to protect it against the elements by any suitable means such as for example roof means with openable and/or retractable portions or closure means.

5           Whilst the preferred form of construction described above with reference to Figures 1 to 5 is particularly suitable for use with the largest sizes of bulk carrier vessels, an alternative more economic form of construction now to be described may be used with smaller  
10 vessels.

          The terminal of Figure 6 is generally similar in construction to the above described embodiment, like parts being indicated by like reference numbers, except for the construction of the radially extending portion 15 and some  
15 consequential differences in the form of the upper portion of the tower 3. In this case the radial portion 15 comprises a jib 45 supported outwardly 46 of the central part of the rotatable portion 10, by a winch means 47 connected  
20 at its other end to a rotatable part 51 on the upper portion 7 of the tower 3 above said rotatable portion 10 so that said jib 45 can be raised or lowered at its outward end 48, as well as being rotated around the tower 3 together with the vessel 1 moored thereto.

          At the outward end 48 of the jib 45 there is  
25 pivotally connected a discharge chute 29 which is also supported by a respective winch means 50 connected at its other end to the rotatable part 51 on the fixed upper portion 7 of the tower 3 and which is disposed for receiving coal from the outer end of a conveyor 27 which  
30 extends along the jib 45. Thus by adjusting the inclination of the jib 45 and discharge chute 29 the 'reach' of the free end of the discharge chute 29 out from the tower 3 can be varied within a relatively wide range thereby permitting access to different parts of the ships  
35 hold(s). In addition the position of the vessel 1 relative

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to the discharge chute 29 can be varied by moving the vessel relative to the tower. Conveniently this may be effected by initially mooring the vessel to the tower 3 at a distance therefrom and then gradually bringing the vessel in, for example, by winching in the mooring line 2, whilst maintaining the vessel under "slow astern" away therefrom. Although the jib 45 and chute 29 will normally move together with the rest of the rotatable portion 10 and hence remain substantially in line with the vessel 1, it would also be possible to swing the jib through a limited arc to permit movement of the discharge chute 29 transversely of the vessel 1 to facilitate the full loading of the vessel's holds.

In Figs. 7 to 11 like reference numerals are used to indicate like parts corresponding to those in the above described embodiments.

In Fig. 7 a vessel 1 is shown moored at a tower 3 on whose upper portion 7 is mounted a rotatable portion 10. As may be seen in Fig. 9 the vessel 1 is moored in conventional manner to an elongate member in the form of a floating pier 25 which is connected to the central part of the rotatable portion 10 via a flexible triangulated linkage 53 of the type described in British Patent No. 1,520,271 and available from Cargospeed Limited, Greenock, Scotland, and a connecting frame 54 hingedly connected at one end 56 to the flexible linkage 53 and pivotally connected 57 at its other end 58 to opposite sides of the central annular part of the rotatable portion 10 so that the longitudinal axis of the pier 25 extends through the vertical axis of the tower 3. It will be appreciated that with the horizontal pivoting and hinging axes of the above form of connection considerable differences in elevation of the pier 25 relative to the tower 3 due e.g. to differing tidal conditions are readily accommodated without the need for changing the elevation of the rotatable portion 10. The flexible linkage also has the advantage

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of relieving rolling, pitching and heaving forces from being transmitted by the pier to the connecting frame and tower under adverse weather conditions.

As in the above described embodiments the pier 25 includes an underwater member 58 which in this case has negative buoyancy and serves as a keel member (see Fig.8) which provides additional stability to the pier particularly against rolling thereof. This is important in the present context because of the relatively narrow breadth of the pier desirable to minimize the offset of the centre-line of the vessel from the pivotal axis of the rotatable portion of the tower. Also in this case the keel member 58 is provided with a plurality of transversely extending propulsion or thruster units 59 (see Fig. 8). Activation of these will tend to swing the pier 25 round the tower 3. This can be used to advantage in for example final docking of a vessel 1 by bringing the pier close against the side of the vessel (and conversely during unberthing) or in adverse sea conditions e.g. where tidal and/or current forces and wind forces are acting on the pier in opposite directions to optimise azimuthing of the pier with respect to the tower 3. Operation of the propulsion units can also be used to relieve additional stresses under storm conditions e.g. by thrusting radially inwardly towards the tower, tension loading in the connecting linkage can be relieved.

In this case the tunnel 13 is brought up from the seabed 5 as it approaches the tower 3 to enter a side opening 12 in the tower which opening 12 is in this case above sea level 8. Thus the coal carrying conveyor 40 at the tower end is inclined upwardly from the horizontal and in fact continues to rise as it passes through the interior of the tower 3, elevating the coal as it does, until it discharges the coal onto a generally annular coal conveyor 60 constituting part of a coal distribution means supported on the rotatable portion 10. In the embodiment of Fig. 11

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annular coal conveyor 60a is of the endless belt type extending circumferentially around the tower 3 to a discharge point between opposed ends of the belt run at which point the coal is discharged onto one end of a radially extending conveyor system 27 which conveys the coal out onto the vessel 1. With this arrangement it will be appreciated that when the vessel is held in alignment by the thrusters 59 so that the radially extending conveyor system 27 aligns itself with the coal carrying conveyor belt 40 since in this case the coal falls directly from the latter onto the former between the opposed ends of the generally annular conveyor belt 60a at the discharge point of the latter. In the embodiment of Fig. 7, the annular coal conveyor 60b is in the form of an I-shaped section ring with the upright on the radially outermost side. The ring, rotated by a drive 75, carries coal on the base of the section around the tower 3 until it is deflected radially inwardly off the ring by a transversely extending deflector plate 61a (see Fig. 10) into a downwardly extending semi-spiral chute 61b connected thereto, onto the radially outwardly extending conveyor system 27. Fig. 7 also shows a tensioning system 62 for the shore-to-tower coal carrying conveyor belt 40. By linking the deflector plate 61 to the rotatable portion 10 or the radially extending conveyor system so that it follows the swinging of the pier around the tower 3 coal transfer between the tower and vessel can continue substantially uninterrupted. Coal delivered from the top end of conveyor 40 is thrown to the outer portion of the annular conveyor 60 so that it builds up on the conveyor 60b and does not fall onto the inner open area which is swept by the deflector plate 61a and chute 61b during azimuthing of the pier 25.

By utilizing an inclined tunnel section as shown in Figs. 7 and 11 it is possible to dispense with a separate coal elevating system in the interior of the tower 3. This has the significant advantage of minimising dust generation inside the tower 3 and the various problems



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associated therewith. Although the reduced draught above the terminal inclined section of the tunnel 13 limits the closeness with which the vessel 1 can approach the tower 3 and prevents direct mooring thereto because of the collision risk during swinging (even though in most orientations the vessel will be clear of the tunnel anyway) the mooring of the vessel 1 to the floating pier 25 overcomes these particular problems. Desirably though the inclined tunnel section with its supporting legs 64 is provided with marker buoys 65 for added safety.

The radially extending conveyor system 27 (as best seen in Fig. 11) comprises a connecting endless conveyor belt 66 supported on a framework 67 which pivots intermediate its ends about a horizontal pivot shaft 68 mounted on the flexible linkage 53. This connecting conveyor belt 66 discharges via a hopper 69 onto an endless distributing conveyor belt 70 which runs the length of the pier 25 and is provided with one or more conventional tripper units 71. The latter are movable along the pier and can either discharge coal onto a transversely extending final distribution conveyor belt 72 or return it to the pier conveyor belt 70 for carriage further along the pier 25. The transverse conveyor belt 72 is movable laterally of the tripper unit 71 so that its discharge end 73 can be shifted from one side of the vessel hold 74 to another.

Although with both the towers of Figs. 7 and 11 the vessel is not moored directly to the tower and is normally moored to the pier at two or more points, the vessel behaves as if it were in a single point or azimuthal mooring system insofar as it can swing more or less freely around the tower whilst moored thereat. The expression azimuthal mooring type tower is accordingly used herein to include such forms of construction also.

Figure 12 shows a coal carrying vessel 101 secured by conventional mooring means 102 to an azimuthing mooring

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unloading tower 103. The tower 103 comprises a base 104 secured to the sea bed 105 by suitable means e.g. piles, an upper part 106, extending up above the water-line 107 and a narrower interconnecting portion 108.

5           The upper part 106 includes a rotatable portion 9 to which the vessel is moored so that the vessel can swing around the tower 103 under the influence of e.g. wind and tide, whilst remaining moored thereto. The rotatable portion 109 is provided with a hopper 110 for  
10 receiving coal from the vessel 101 and channelling it down into the tower 103 through which it passes downwardly to the base 104 where it is received on the end 111 of a conveyor means such as an endless conveyor belt 112. In  
15 order to minimize the possibility of damage to the installation the coal is desirably slowed in the course of its downward passage by, for example, baffles 121 positioned in the interconnecting portion 108 of the tower 103.

20           The conveyor belt 112 is housed inside a tunnel 113 which extends along or under the sea bed 105 from the base 104 of the tower 103 to a discharge point 114 which is conveniently on dry land, and will usually be at a committed service installation such as a coal-fired power station 120.

25           Although with azimuthing mooring systems in general the mooring cable(s) normally remain under tension, the vessel tending to swing about the mooring point, only, it is possible under certain conditions that the vessel  
30 may be moved e.g. by tidal forces, towards the tower 103 and the latter is therefore advantageously provided with suitable protection means such as inflatable fenders 115 and/or maintained under "slow astern" to avoid any possible collision damage.

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The vessel 101 is provided with an elevator means such as a conveyor belt 116 or preferably a screw elevator 117 (shown in phantom) or other means, such as a bucket or flight elevator, which have a minimal horizontal extent, for raising the coal from the hold of the vessel up to its main deck level 118. The coal is then carried over the bow or side of the ship by further conveyor or chute means 119 which terminate directly above the hopper 110 of the tower 103 so as to discharge the coal into said hopper.

It will be appreciated that with such an unloading system, unloading can be made very simple and labour requirements reduced to a minimal level. Thus by suitable choice of the location of the tower the latter can be made accessible to the largest vessels which can be simply and quickly moored thereto. Then once the further conveyor or chute means 119 have been positioned over the hopper 110, unloading can proceed substantially continuously and automatically without the need of any manual labour - at least as far as the discharge point.

It will be appreciated that various modifications can be made without departing from the scope of the invention as defined in the following claims. Thus the tunnel may be disposed under the sea bed or possibly even supported above the sea bed as long as it is positioned well clear of the hull of any vessel moored to or approaching the tower. Naturally the inshore end may extend well above the water line depending on the form of the shore and the location of the discharge point. In general any conventional form of tunnel construction which is substantially watertight may be employed, for example, the tunnel may be made of reinforced concrete and/or of precast concrete sections assembled in situ. The tower itself may also be made by any form of construction suitable for use in such a structure - as for example for off-shore oil exploration and production platforms. Conveniently though the tower may be made of reinforced concrete and/or steel plate

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construction.

5 The embodiment of Figs. 13 and 14 is generally similar to that of Figs. 12 and like parts have been indicated by like reference numbers, the radially extending coal distribution means and mooring means of the rotatable portion 109 being more akin to those of the loading terminal of Fig. 11. Also the coal receiving means are in the form of a travelling crane 122 with a grab 123 in place of the on-board conveyor 116 or elevating means 117.

10 In more detail the rotatable portion 109 is mounted for vertical movement on the tower 103 via bearing means 124 similar to those 11 in Fig. 1. The rotatable portion 109 is hingedly connected 126 by a triangulated linkage 125 similar to that 53 in Fig. 9, to a floating pier 127 similar to that 25 in Figs. 8 and 9. The latter  
15 has endless conveyor belts 128 with chute means 129 into which the grab 123 discharges and with an inclined portion 130 the radially inner end 131 of which discharges into the tower 103 down onto the tunnel conveyor 112.

20 As may be seen in Fig. 14 a second vessel 132 is moored to the pier 127 on the opposite side thereof from the first mentioned one 101. This enables unloading of successive vessels to proceed with the minimum delay since the next vessel can be moored in position while the first  
25 is still unloading without waiting for the latter to first vacate its mooring position. It is also possible for unloading of both vessels to proceed simultaneously where sufficient grab means etc. are provided. Such an arrangement is of course equally applicable to the loading  
30 terminals of Figures 1 to 11.

#### INDUSTRIAL APPLICABILITY

The present invention is applicable to the handling of particulate materials used in the energy producing and other fields of industry.

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CLAIMS

1. An azimuthal mooring type tower for use in loading or unloading particulate material onto or from a bulk carrying vessel, which tower has a base securable to the ground in a body of water accessible to said vessel, and an upper portion supporting a rotatable portion mounted for rotation around said upper portion and provided with a mooring means, said tower having an opening below said upper portion for connection, in use of said tower, to a tunnel provided with material conveying means and extending below the level of the hull of a said vessel moored at said tower, said tower including a material conducting means extending upwardly from a position in proximity to said opening for conducting, in use of the tower, material between said tunnel, and a material distribution means having a portion extending generally radially of said rotatable portion and arranged for rotation therewith and for discharging or receiving material at at least one position spaced from said tower, for loading or unloading, respectively, of a vessel moored to said rotatable portion, in use of said tower.

2. An azimuthal mooring type tower for use in loading material onto a material carrying vessel, which tower has a base securable to the ground in a body of water accessible to said vessel, and an upper portion supporting a rotatable portion mounted for rotation around said upper portion and provided with a mooring means, said tower having an opening below said upper portion for connection, in use of said tower, to a tunnel provided with material conveying means and extending below the level of the hull of a said vessel moored to said tower, said tower including a material elevating means extending upwardly from a position in proximity to said opening for conveying, in use of the tower, material carried through said tunnel, up to said upper portion for discharging material thereat onto a material distribution means having a portion



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extending generally radially of said rotatable portion and arranged for rotation therewith and for discharging material at at least one position spaced from said tower, for loading of a vessel moored to said rotatable portion, in use of said tower.

3. A tower as claimed in Claim 2 wherein the material distribution means includes a generally annular endless conveyor belt extending around the tower between opposed spaced apart ends thereof at a discharge point thereof for discharging coal onto said radially extending portion of said material distribution means, said belt being mounted on said rotatable portion.

4. A tower as claimed in Claim 2 wherein the material distribution means includes a generally L-shaped section plate type ring conveyor mounted so as to be continuously rotatable, a deflector plate being disposed in proximity to a load carrying surface thereof for deflecting material radially inwardly off said ring conveyor onto said radially extending portion of said material distribution means.

5. A tower as claimed in any one of Claims 2 to 4 wherein said radially extending portion of said material distribution means comprises endless belt conveyor means.

6. A tower as claimed in Claim 5 wherein said endless belt conveyor means is provided with one or more tripper means for discharging material onto respective transversely extending conveyor means having discharge ends disposable in use above the hold of a said vessel for discharging material thereinto.

7. A tower as claimed in any one of Claims 2 to 4 wherein said radially extending portion comprises a jib extending generally radially from the rotatable portion and supported, at a position spaced outwardly from said rotatable portion, by a winch means connected to a rotatable part of the upper portion of the tower above

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said rotatable portion so that said jib can be raised or lowered at its outward end.

8. A tower as claimed in any one of Claims 2 to 4 wherein said material elevating means is in the form of inclined conveyor belt means.

9. An azimuthal mooring unloading tower suitable for use in unloading material from a material carrying vessel, said tower having: a base securable to the ground in a body of water accessible to said vessel; an upper portion provided with receipt means for receiving material discharged from a vessel in use of the tower and directing the material downwardly through the tower towards said base; an opening below said upper portion for connection, in use of said tower, to a tunnel provided with material conveying means and extending below the level of the hull of a said vessel moored at said tower; and a rotatable portion having mooring means for securing of a vessel thereto and being rotatable around a vertical axis of the tower to permit movement of the vessel, due to wind and/or tidal forces, around the tower whilst remaining moored thereto, in use of the tower.

10. A tower as claimed in Claim 9 in which an intermediate portion between the base and the top is provided with decelerating means for reducing the speed of fall of material therethrough.

11. A tower as claimed in Claim 10 wherein the decelerating means comprises a plurality of baffles.

12. A tower as claimed in Claim 10 or Claim 11 wherein the radially extending portion of the material distribution means comprises endless belt conveyor means.

13. A tower as claimed in Claim 12 wherein is provided at least one grab means arranged in proximity to said endless belt conveyor means for transferring coal from the hold of a said vessel to said endless belt conveyor means.

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14. A tower as claimed in any one of Claims 1, 2 and 9 wherein said radially extending portion comprises an elongate member provided with float means for substantially supporting said member in said body of water.
- 5 15. A tower as claimed in Claim 14 wherein said elongate member is in the form of a floating pier.
16. A tower as claimed in Claim 14 wherein the rotatable portion is connected to said upper portion of the tower for relative axial movement relative thereto whereby  
10 differences in water level relative to the tower may be accommodated.
17. A tower as claimed in Claim 14 wherein the rotatable portion is hingedly and/or pivotally connected to said elongate member for permitting relative vertical movement  
15 therebetween.
18. An azimuthal mooring type loading or unloading terminal comprising an azimuthal mooring type tower according to any one of Claims 1, 2 and 9 disposed in a position in a body of water accessible to a bulk carrying vessel with the base of said tower secured to the  
20 ground in said body of water and with the top of said tower projecting above a high-water level, a tunnel extending between said tower at a level, at least in proximity to said tower, below that of the hull of a  
25 vessel moored to said tower, and a remote supply point, said tunnel including conveyor means for conveying material between said tower and said supply point.
19. A terminal as claimed in Claim 18 in which said tunnel is inclined upwardly in proximity to said tower.
- 30 20. A terminal as claimed in Claim 19 wherein the conveyor means in said tunnel comprises at least one endless conveyor belt.



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21. A method of loading or unloading particulate material onto or from a vessel comprising the steps of mooring the vessel at the rotatable portion of an azimuthal mooring type tower of an azimuthal mooring type loading terminal according to Claim 18; positioning a discharging or receiving portion of said radially extending portion of the material distribution means above a hold opening of the vessel; using the tunnel material conveying means, tower material conducting means, and material distribution means to convey material between said vessel and said remote supply point.

22. A method as claimed in Claim 21 which includes the step of radially displacing said discharging or receiving portion of said radially extending portion of the material distribution means and the vessel relative to each other for loading or unloading, respectively, different parts of the hold and/or different holds of the vessel.



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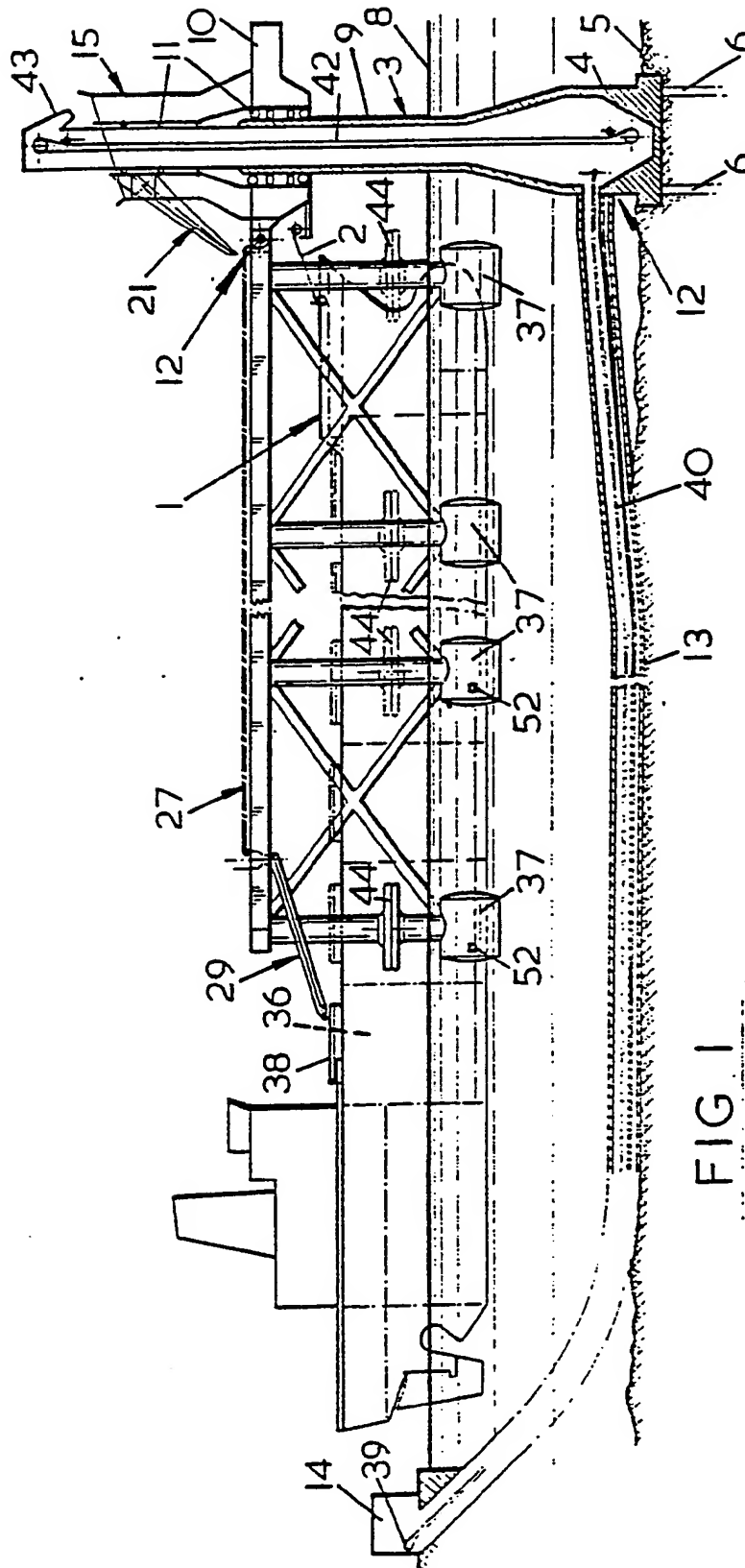
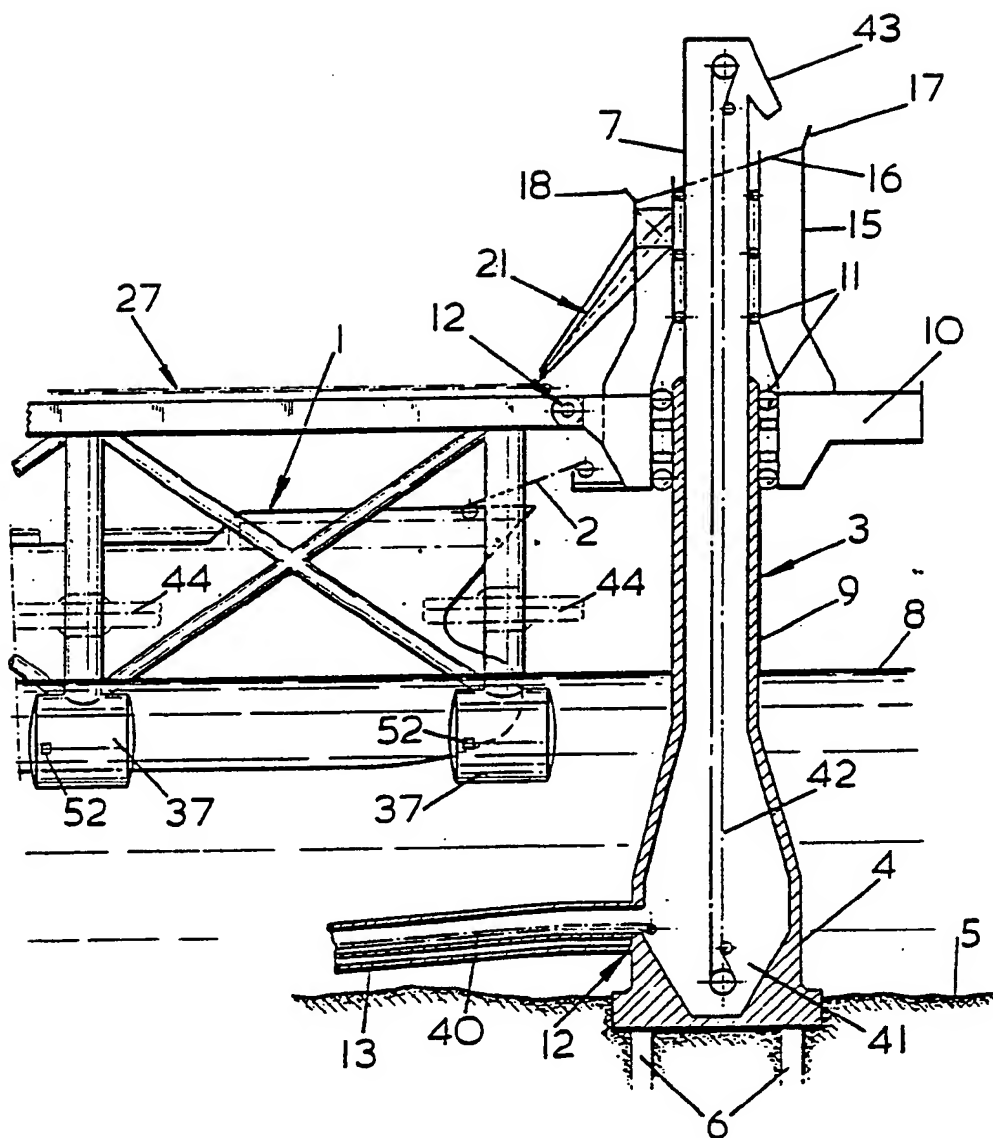


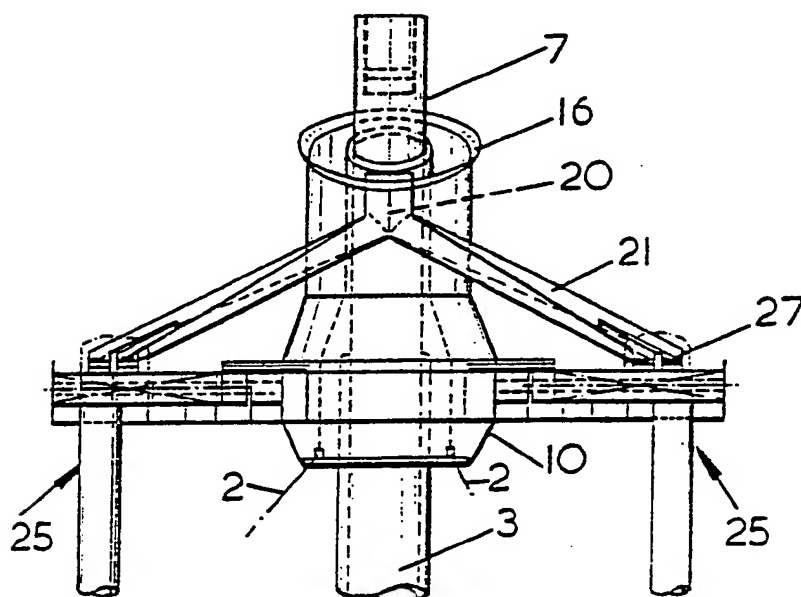
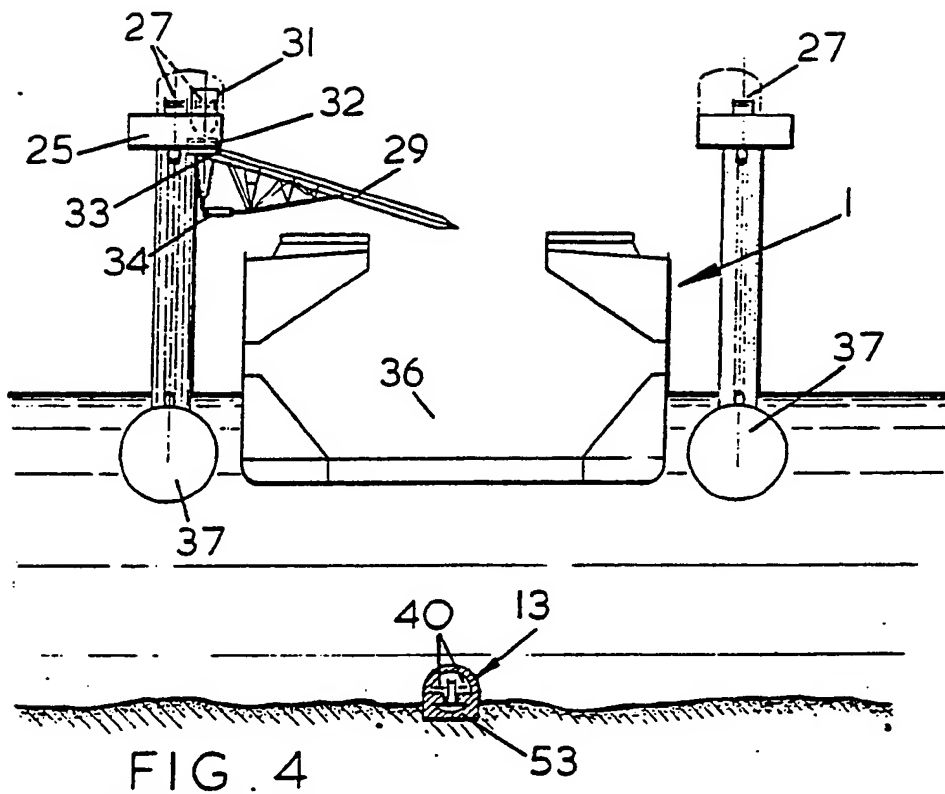
FIG. 1

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FIG 2



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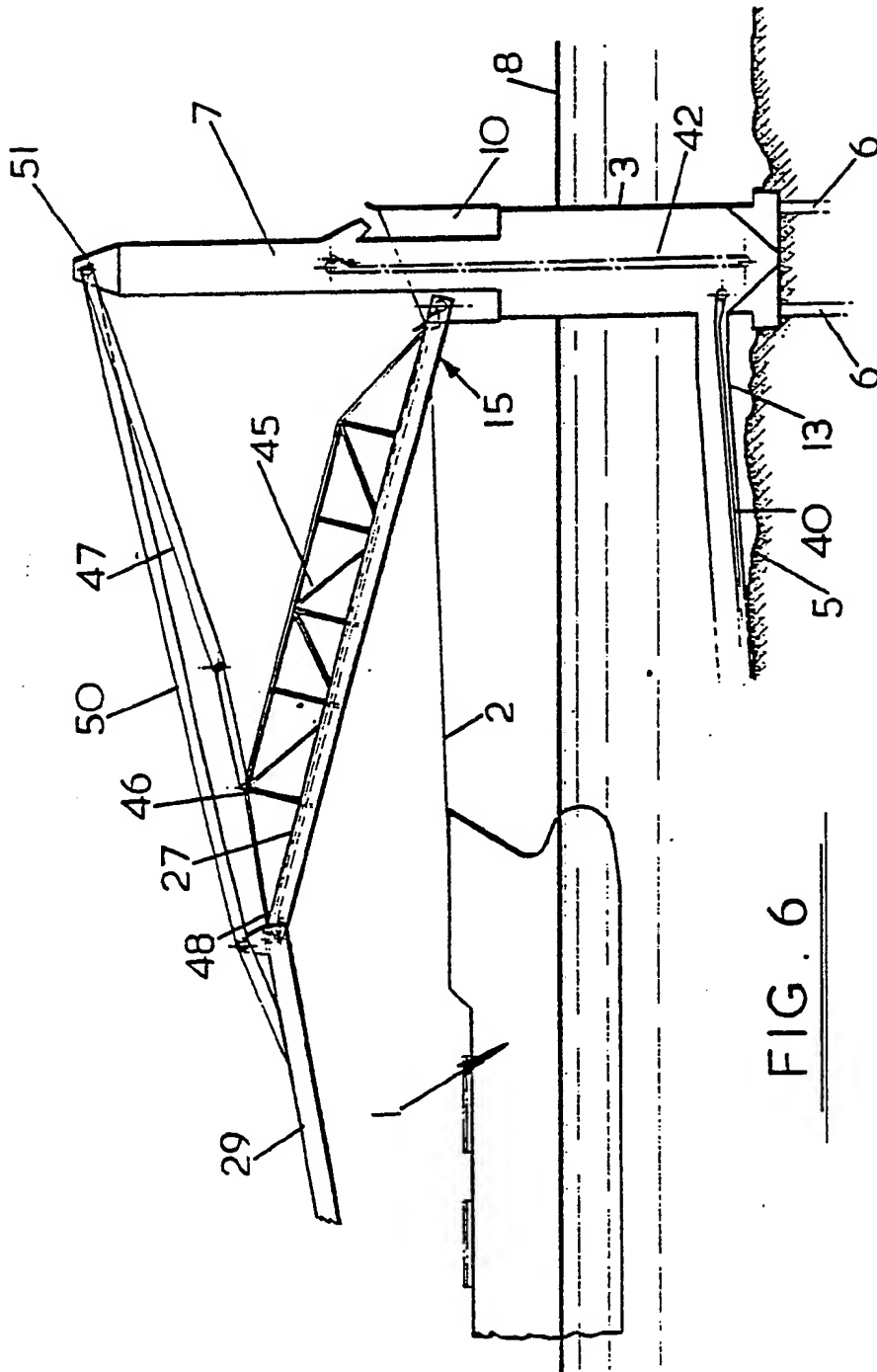


FIG. 6

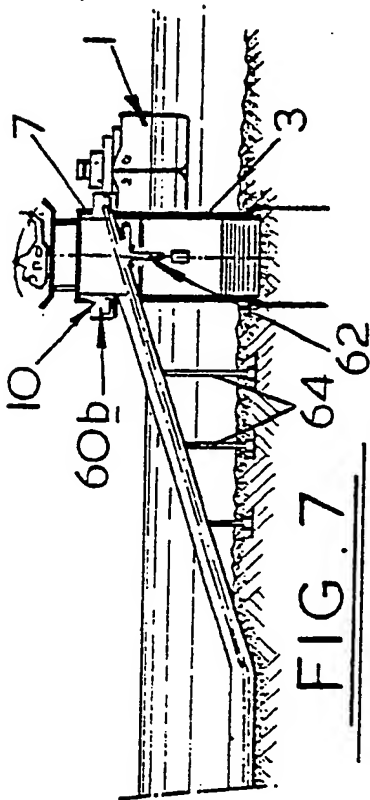


FIG. 7

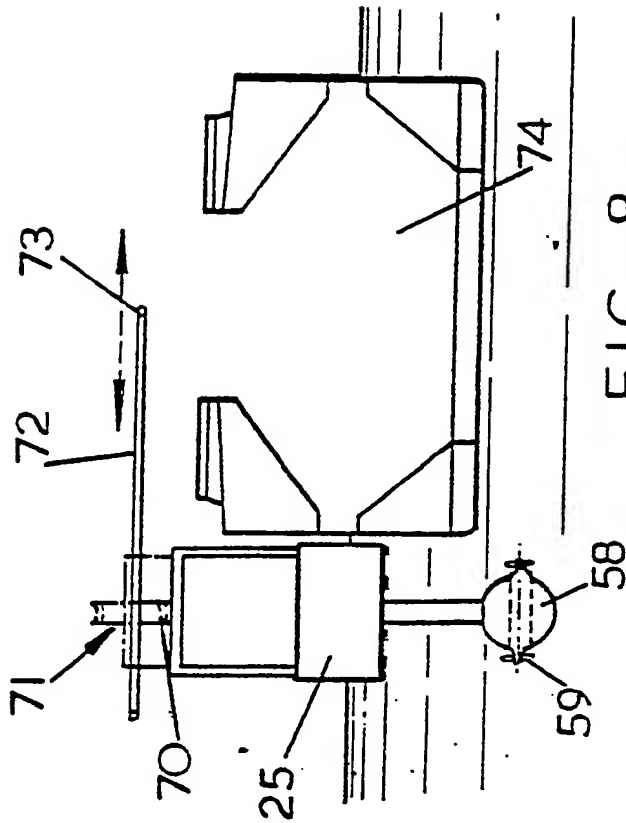


FIG. 8

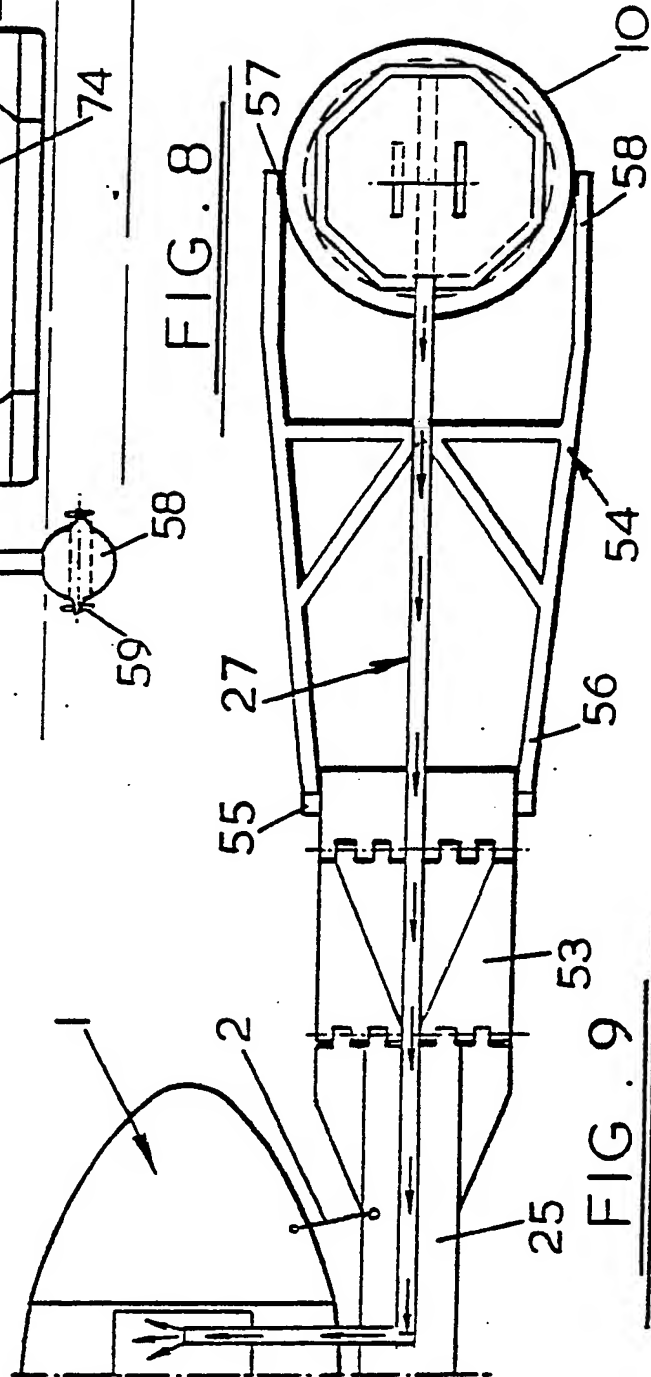


FIG. 9

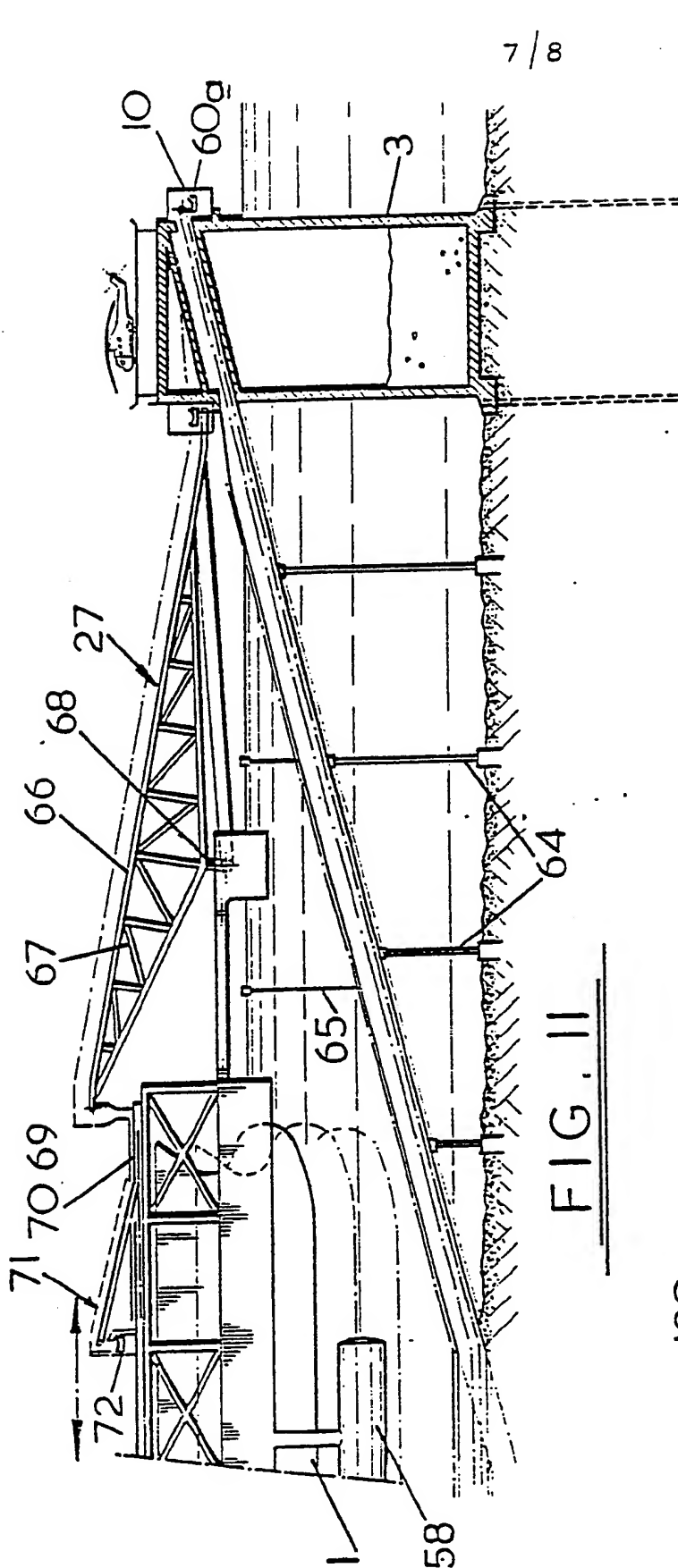


FIG. 11

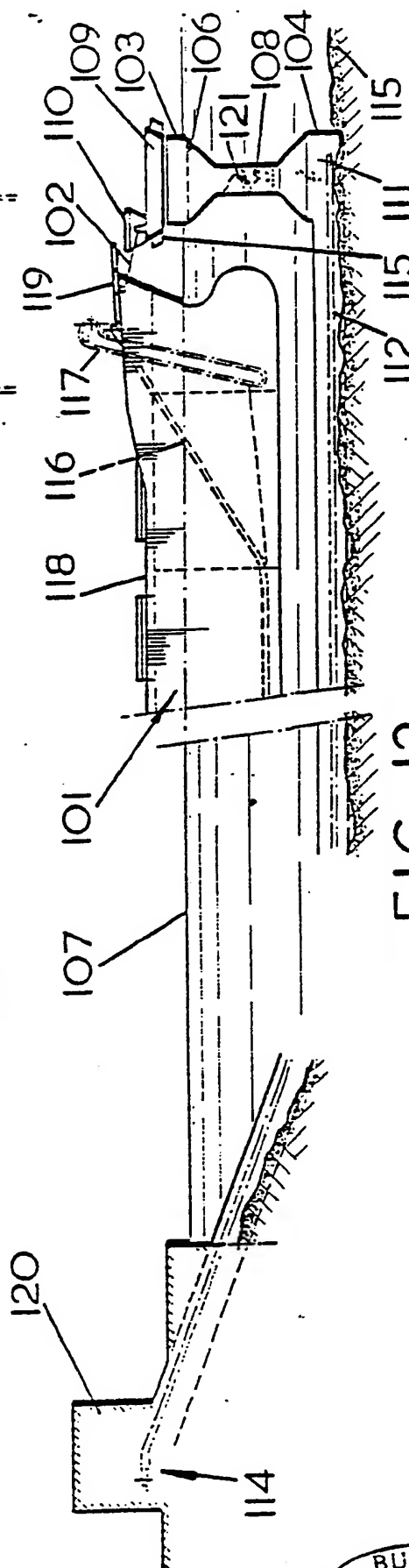


FIG. 12



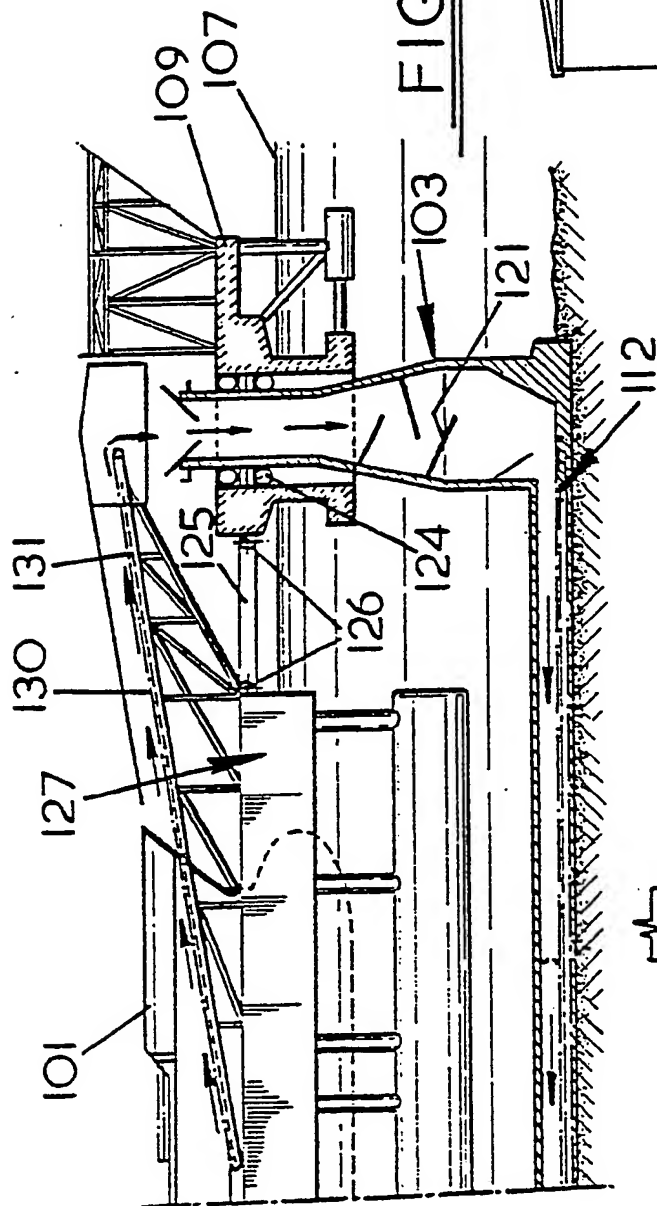


FIG. 13

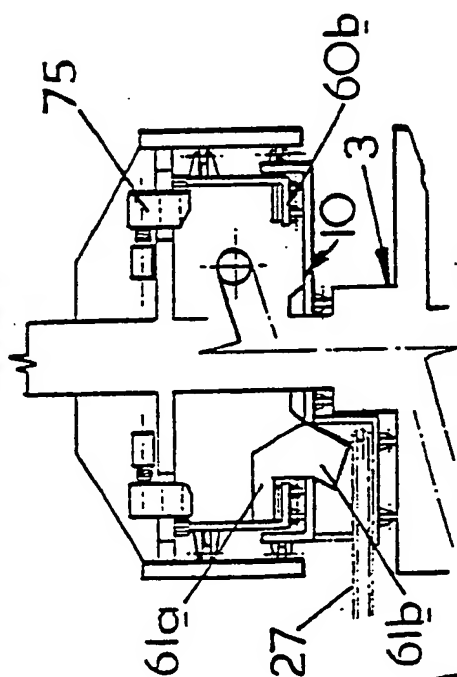


FIG. 10

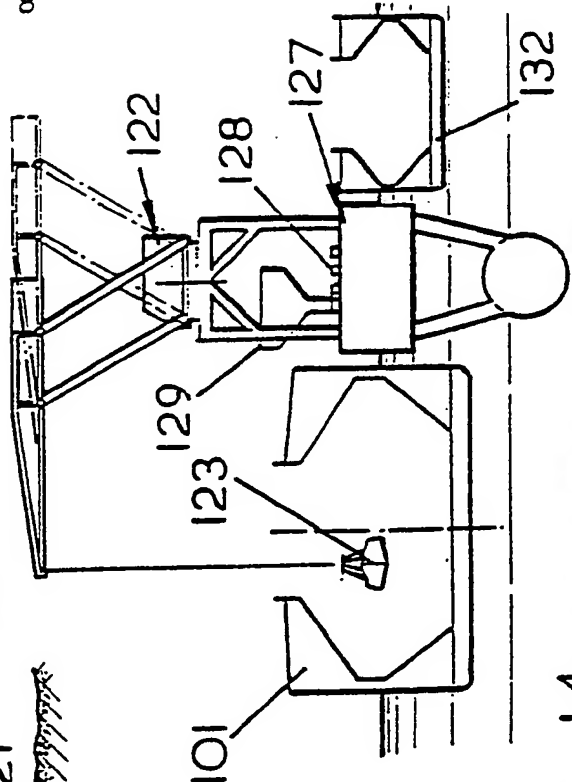


FIG. 14

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/GB 81/00254

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>3</sup> : B 63 B 27/22; B 65 G 67/62; B 63 B 21/50		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
IPC <sup>3</sup>	B 63 B; B 65 G	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category <sup>6</sup>	Citation of Document, <sup>15</sup> with Indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>16</sup>
A	US, A, 3245438 (G.A. McCAMMON) 12th April 1966, see column 2, lines 6-72; column 3, lines 1-48; figures 1 and 2	1,2,9,14, 15
A	GB, A, 1286759 (MANNESMANN A.G.) 23rd August 1972, see page 2, lines 69-130; page 3, lines 1-41; figures 1 to 7	1,2,9,14, 15,16,17
A	US, A, 3704796 (P. DE DEMANDOLX DEDONS et al) 5th December 1972, see column 2, lines 47-67; column 5, lines 58-67; column 6, lines 1-9; figures 1A, 1B, 8 and 9	1
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<p><sup>18</sup> Special categories of cited documents: <sup>13</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"Δ" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>2</sup>		Date of Mailing of this International Search Report <sup>2</sup>
25th February 1982		9th March 1982
International Searching Authority <sup>1</sup>		Signature of Authorized Officer <sup>16</sup>
EUROPEAN PATENT OFFICE		G.L.M. Krüger